

TABLE 6-4 (continued).
FIELD ASSESSMENT CRITERIA AND THRESHOLDS (FROM R2 RESOURCES 2001).

Habitat Parameter	Habitat Condition		
	Good	Fair	Poor
High Gradient Streams			
Riparian condition	High recruitment potential	Medium recruitment potential	Low recruitment potential
Substrate composition in spawning areas	Gravel or cobble dominant	Gravel or cobble subdominant	Bedrock or boulder dominant
Embeddedness	N/A	N/A	N/A
Bank condition	Few side slope failures; where present, revegetation is well established	Side slope failures scarce, or if present, <50% are revegetated	Side slope failures are common and actively eroding
Pool frequency	<2 CW/pool	2-4 CW/pool	>4 CW/pool
Channel pattern/bedform	Well developed step-stool bedform	Irregularly spaced or poorly defined step-pool bedform separated by cascades	Cascade bedform
Large woody debris	If CW is 33 to 66 feet, >0.50 key pieces/CW If CW<33 feet, >0.30 key pieces/CW and >2 total pieces/CW	If CW is 33 to 66 feet, 0.20 to 0.50 key pieces/CW If CW<33 feet, 0.15 to 0.30 pieces/CW and 1-2 total pieces/CW	If CW is 33 to 66 feet, <0.20 key pieces/CW If CW<33 feet, <0.15 key pieces/CW and <1 total piece/CW
Note: CW = Channel Width			

Habitat Value and Rating

A qualitative assessment of each subbasin was conducted based on stream classification, complexity (number and size of the tributaries), and habitat potential (amount of spawning or rearing habitat). The value of each subbasin was classified as low, moderate, or high, depending on the amount of potential spawning and rearing habitat.

The habitat condition of each subbasin was rated as good, fair, or poor based on the existing conditions compared to what is described as natural conditions for the channel types described by the USBEM methodology Appendix E. Stream reaches that provided highly suitable habitat were rated as “good;” reaches that have been degraded but still provided habitat use were rated as “fair;” and reaches with negligible habitat use or a portion of the salmonid life history habitat requirements that are significantly impaired were rated as “poor.”

State of the Subbasin

This “state of the subbasin” is a summary of the existing conditions and impairments to the habitat in each subbasin and identifies potential areas for habitat improvement projects and remaining high quality habitat areas suitable for preservation.

6.2 SUBBASIN 1 STREAM HABITAT CLASSIFICATION RESULTS

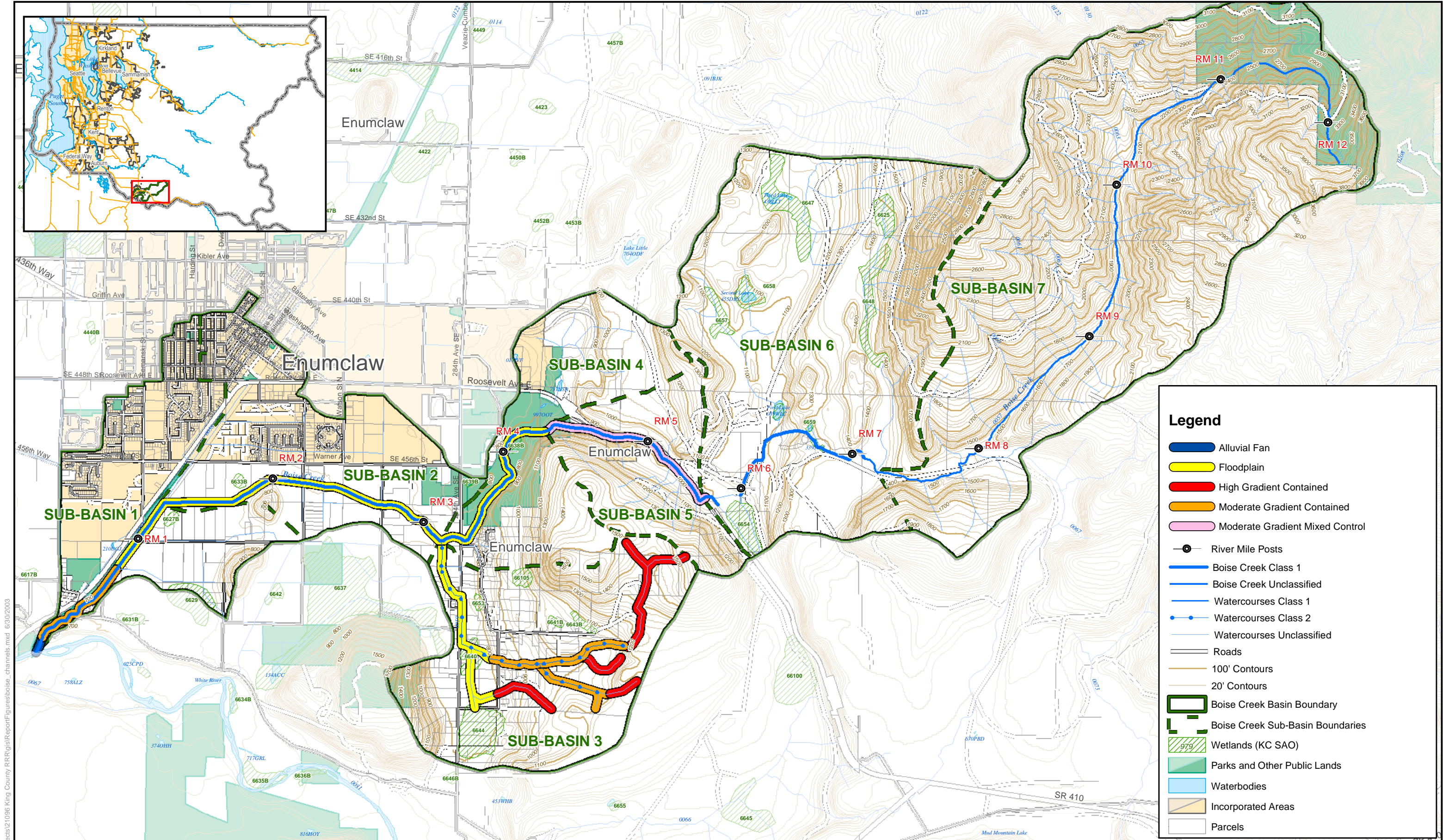
6.2.1 General Characteristics (Boise Creek: RM 0.0 – 1.2)

Subbasin 1 of Boise Creek has two distinct reaches. From RM 0.0 to 0.8 is a moderate-gradient contained channel that flows through a steep ravine vegetated with relatively abundant native riparian vegetation, including deciduous trees and conifers, as shown in Figure 6-1. However, field investigations and examination of historical maps reveal that much if not all of this segment of Boise Creek has been relocated into the ravine, as well as the flatter gradient area downstream of Mud Mountain Road. From RM 0.8 to 1.2, the subbasin is a floodplain channel type that has been degraded by channelization, straightening, construction of levees and revetments, and removal of riparian habitat. It is likely that this upper reach historically was a meandering stream, as is commonly found with floodplain channel types. Table 6-5 summarizes the channel types in Subbasin 1.

TABLE 6-5. LENGTH OF EACH CHANNEL TYPE ALONG BOISE CREEK IN SUBBASIN 1	
Stream Type	Length (feet)
Alluvial Fan	484
Floodplain	2,631
High Gradient Contained	0
Mod. Gradient Contained	3,490
Moderate Gradient Mixed Control	0
Palustrine	0
Total	6,605

Although the steeper portion of Subbasin 1 has not been affected to the same degree by adjacent land use practices as other reaches, its habitat value is still relatively low because of the high channel gradient, fast stream energies, large substrate, lack of LWD and paucity of pools.

The reach downstream from Mud Mountain Road offers the greatest potential for habitat improvement in Subbasin 1. The land through which the stream flows is in public ownership and there are few impediments to restoration of a sinuous channel and floodplain, terminating in an alluvial fan at the confluence of the White River. Riparian habitat restoration and LWD placement would also improve habitat conditions in this reach.



Legend

- Alluvial Fan
- Floodplain
- High Gradient Contained
- Moderate Gradient Contained
- Moderate Gradient Mixed Control
- River Mile Posts
- Boise Creek Class 1
- Boise Creek Unclassified
- Watercourses Class 1
- Watercourses Class 2
- Watercourses Unclassified
- Roads
- 100' Contours
- 20' Contours
- Boise Creek Basin Boundary
- Boise Creek Sub-Basin Boundaries
- Wetlands (KC SAO)
- Parks and Other Public Lands
- Waterbodies
- Incorporated Areas
- Parcels

Restoration of the channel and riparian corridor within the ravine upstream from Mud Mountain Road would be more problematic because much of the adjacent land is in private ownership and the ravine walls are extremely steep and unstable in many areas. Nonetheless, it may be possible to access the stream from a recreational trail within publicly owned right-of-way along the right bank in order to plant conifers and place LWD in certain locations.

6.2.2 Subbasin Alteration

Effective Impervious Area

The land use analysis indicated that Subbasin 1 is 874 acres in size and has an EIA of 169 acres, yielding a 19 percent EIA, a high level of alteration. This level of alteration is likely to have a significant impact on the hydrologic regime of the stream within this subbasin.

Landscape Alteration

Prior to development, 874 acres of mature forested land cover was present in Subbasin 1. Under existing conditions, only 62 acres of forested land cover (7 percent of the historical area) remain, constituting a high level of landscape alteration.

Impact from Culverts and other Crossings

There are three stream crossings within Subbasin 1, yielding 2.7 crossings per mile, a moderate level of impact. The WRIA 10 report (Kerwin 1999) indicated that the bridges on Boise Creek cause channel constriction.

Flow Modification

The hydrologic analysis indicates a moderate level of flow modification ($Q^2_{\text{post}}/Q^2_{\text{pre}} > 1.25$) in Subbasin 1 (Table 6-6). As confirmed during field investigations, these increased flows are causing instream habitat instability in this reach of Boise Creek.

TABLE 6-6. PRE-DEVELOPED AND POST- DEVELOPED 2-YEAR AND RATIO; RCHRES SEGMENT 100 IN SUBBASIN 1	
Q^2_{pre}	602 cfs
Q^2_{post}	822 cfs
$Q^2_{\text{post}}/Q^2_{\text{pre}}$ ratio	1.37

Channel Modifications and Floodplain Connectivity

The physical structure of the stream channel has been highly altered in Subbasin 1. Approximately 60 percent of Boise Creek in Subbasin 1 has been channelized, eliminating the natural sinuosity of the channel and limiting natural channel migration. Levees have

been constructed along much of the floodplain channel type reach downstream from Mud Mountain Road, essentially eliminating floodplain connectivity in this reach.

Riparian Alteration

The riparian habitat of Subbasin 1 is highly altered. The upper half of the left stream bank is in poor condition due to agricultural activities that have removed the riparian vegetation. Only 41 percent of the riparian corridor is forested (Chapter 2).

Subbasin Alteration Matrix

A high level of watershed alteration has occurred in Subbasin 1 (Table 6-7). All of the subbasin alteration matrix criteria were rated at a high level of alteration except for stream crossings and flow modification, which were rated as moderate. These results suggest that there are numerous impairments to the function of Subbasin 1 and that habitat is significantly degraded.

TABLE 6-7. SUBBASIN ALTERATION MATRIX FOR SUBBASIN 1			
Criteria	Level of Alteration		
	High	Moderate	Low
Effective Impervious Area	19% EIA		
Landscape Alteration	5% of the historical area		
Impact from Culverts and Other Stream Crossings		2.7 crossings/mile	
Flow Modification (Q _{2post} /Q _{2pre} ratio)		1.37	
Channel Modifications and Floodplain Connectivity	60% of the stream length modified		
Riparian Alteration	41% forested		

6.2.3 Benthic Biodiversity

B-IBI data were collected in 1999 and 2000 by King County at Water Quality Sampling Location E2168, located at the bridge on 241st Avenue SE (SE Mud Mountain Road) that crosses Boise Creek near the downstream end of Subbasin 1. The scores are presented in Table 6-8. The low values for all of the parameters suggest that Boise Creek is in poor condition at this location.

TABLE 6-8. B-IBI METRIC SCORES FOR BOISE CREEK AT 241ST AVENUE SE		
	1999 ^a	2000
Total No. Taxa	2	3
E Richness	2	1
P Richness	2	1
T Richness	3	1
Site Score	13	22
Average E Richness	1.7	3
Average P Richness	0.7	1.3
Average T Richness	3.3	4
a. Scores from 1999 are based on the 5-metric method; scores from 2000 are based on the 10 metric method		

6.2.4 Summary

Field Assessment

The habitat conditions of Boise Creek were assessed at 241st Avenue SE and at 252nd Avenue SE road crossings. At the 241st Avenue SE crossing, fish passage was unobstructed, riparian habitat was relatively intact, and the substrate embeddedness was relatively low. However, the stream appeared to have been re-routed into the ravine upstream from the bridge, and, as mentioned above, the channel downstream from the bridge was artificially created. Little LWD was observed in this reach. At the same time, riparian habitat in this reach is dominated by relatively mature coniferous and deciduous trees, providing the potential for long-term recruitment of LWD to the stream. Because of channel confinement and lack of energy dissipation, the substrate composition in spawning areas, pool frequency, channel pattern/bedform, and LWD were rated as poor. The reach of Boise Creek near 241st Avenue SE is a series of fast riffles and runs that do not provide quality spawning and rearing habitat due the large substrate and lack of channel complexity. Because of these conditions, the channel serves mainly as a salmonid transportation corridor.

At the 252nd Avenue SE road crossing, all of the criteria were rated as poor with the exception of fish passage, which was rated good. This segment of Boise Creek has been straightened and channelized with alternating riffle and run habitats and limited amounts high quality spawning and rearing habitat are present. The riparian habitat has been removed from much of this segment of the stream by adjacent residential landowners, resulting in bank instability. High turbidity prevented accurate evaluation of the substrate, but it is believed to be largely unsuitable for spawning.

Habitat Value

Habitat value within Subbasin 1 is at best moderate because of low channel complexity and a lack of off-channel habitat and fish bearing tributaries. The high-gradient area at the downstream end of this reach provides little spawning and rearing habitat due to the high

gradient and large sized substrate. Although the channel downstream from Mud Mountain Road currently serves as a salmonid transportation corridor, salmonid access from the White River may be threatened by the removal in 2003 of a concrete-encased water pipeline across the White River just downstream from Boise Creek. A large amount of gravel and cobble had accumulated over many decades just upstream from this structure, and its removal has already significantly altered sediment transport within this segment of the White River. Long-term monitoring will be needed to ensure that the mouth of Boise Creek does not become perched due to channel incision on the mainstem as the river equilibrates in response to removal of this artificial sediment impoundment. The upstream, floodplain channel reach is of moderate value, and may support spawning and rearing of salmonids. However, degradation of this reach impairs salmonid production. This reach could be upgraded to high value habitat if instream and riparian habitat conditions were improved.

Rating

Subbasin 1 is a moderate-value subbasin that is highly degraded. The subwatershed in which it is situated primarily comprises rural residential and agricultural land uses and has been highly altered. The habitat in this reach is degraded and homogenous. Although a portion of the subbasin is a floodplain channel type, it lacks sinuosity, pools, structure, and cover typically found in these channel types (R2 Resources 2001).

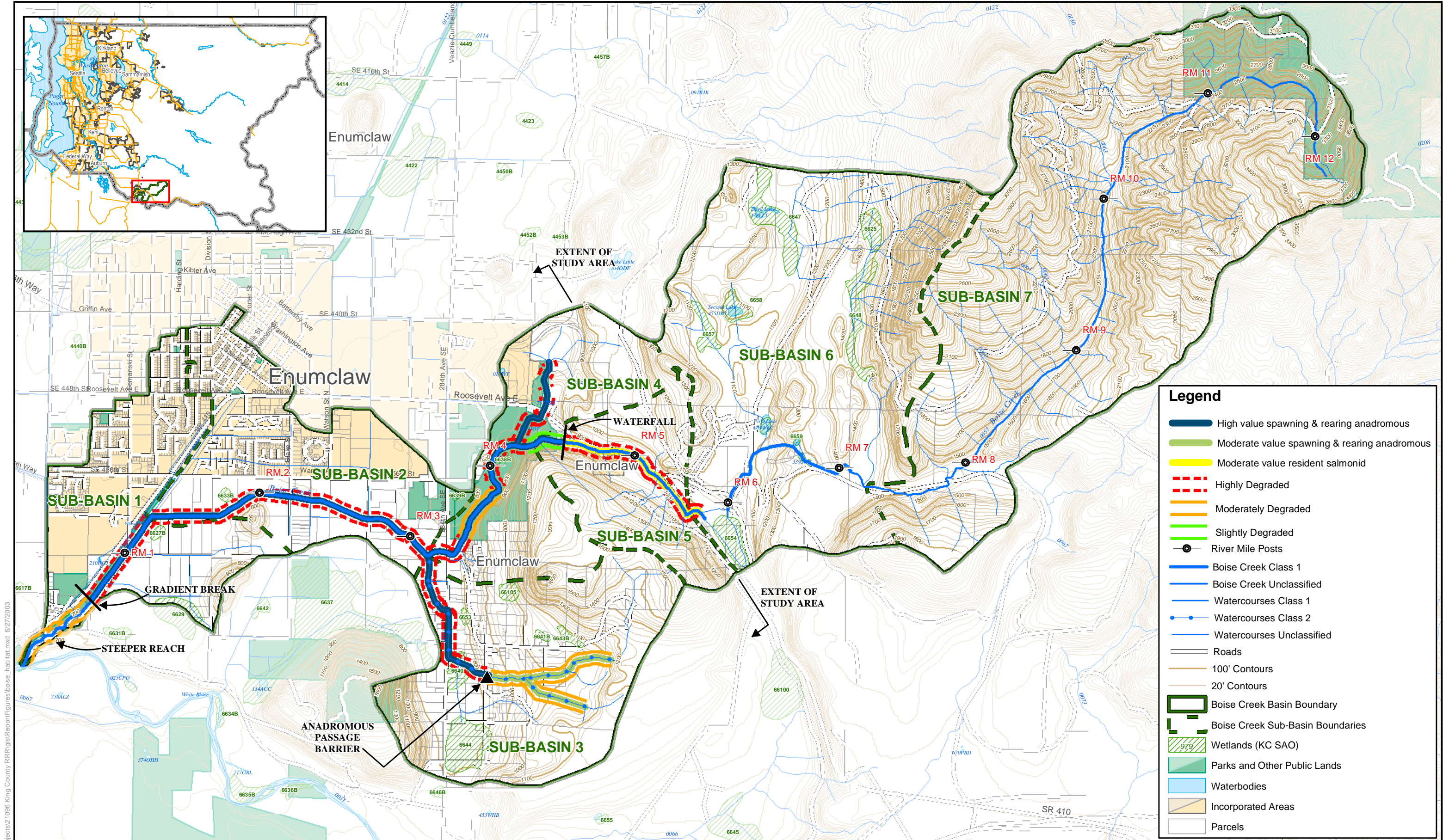
State of the Subbasin

Subbasin 1 has been highly impacted by infrastructure development (construction of SR-410 and a railway that in recent years has been converted to a trail and residential and agricultural development. As a result habitat within this subbasin is in poor condition. Much of the stream channel has been channelized, straightened, and dredged, which has lead to channel incision. The riparian habitat is in moderate to poor condition due to encroachment by agricultural and rural residential development. The reach is also void of LWD. Deposition of fine sediments in this reach that have eroded from upstream areas has also degraded substrate conditions. Restoration efforts in this subbasin should address the overall function of the subbasin. Figure 6-2 shows the habitat value, rating, and condition of the stream.

6.3 SUBBASIN 2 STREAM HABITAT CLASSIFICATION RESULTS

6.3.1 General Characteristics (Boise Creek: RM 1.2 – 3.2)

Boise Creek in Subbasin 2 is a floodplain channel type that flows from the downstream end of the Enumclaw Golf Course at approximately RM 3.2 to the upstream boundary of Subbasin 1 at RM 1.2. The stream is low-gradient, generally straight due to extensive channelization, has poor riparian habitat, few pools, and very little LWD. The riparian vegetation has been removed from nearly all of this reach. Improvement of riparian habitat conditions and increased LWD abundance would significantly improve the habitat in this reach. Table 6-9 summarizes the channel types in Subbasin 2.



\\ENVIR\IMPACTS\2001\projects\21096\King County RRR\gis\ReportFigures\boise_habitat.mxd 6/27/2003

TABLE 6-9. LENGTH OF EACH CHANNEL TYPE ALONG BOISE CREEK IN SUBBASIN 2	
Stream Type	Length (feet)
Alluvial Fan	0
Floodplain	9,977
High Gradient Contained	0
Mod. Gradient Contained	0
Moderate Gradient Mixed Control	0
Palustrine	0
Total	9,977

6.3.2 Subbasin Alteration

Effective Impervious Area

Subbasin 2 is 960 acres in size and has 216 acres of impervious area, yielding a 22 percent EIA, which indicates a high level of impact on this subwatershed.

Landscape Alteration

Under predeveloped conditions, 960 acres of forested land cover was present in Subbasin 2. Currently, only 46 acres of forested land cover remain in the subbasin, a 95 percent reduction of the historical area, indicating a high level of landscape alteration.

Impact from Culverts and other Crossings

There are three stream crossings in Subbasin 2, yielding 1.6 crossings per mile, a relatively low level of alteration. All of the crossings are bridges that do not impair fish passage, however they constrict the stream channel.

Flow Modification

In Subbasin 2, flow modification is reflected in the Q2post/Q2pre ratio range of 1.27 to 1.29 for the three RCHRES segment sites (Table 6-10). This represents a moderate level of modification to the hydrologic regime.

TABLE 6-10. PRE-DEVELOPED AND POST-DEVELOPED 2-YEAR AND RATIO; RCHRES SEGMENTS 200, 210 AND 220 IN SUBBASIN 2			
	RCHRES 200	RCHRES 210	RCHRES 220
Q _{2pre}	536 cfs	547 cfs	495 cfs
Q _{2post}	682 cfs	706 cfs	634 cfs
Q _{2post} /Q _{2pre} ratio	1.27	1.29	1.28

Channel Modifications and Floodplain Connectivity

The stream channel in Subbasin 2 has been highly altered and degraded due to channelization of this reach of Boise Creek. In addition, the channel appears to have been subjected to ongoing dredging in past decades in an effort to increase channel capacity and reduce the frequency of overbank flooding. This, along with elimination of off-channel habitat during conversion from forested conditions to agricultural and residential land uses has reduced floodplain connectivity in this reach.

Riparian Alteration

Subbasin 2 of Boise Creek is highly altered and in poor condition. Livestock grazing and other agricultural land uses have significantly reduced or eliminated the riparian vegetation throughout the subbasin. Seventy-nine percent of the riparian area is dominated by herbaceous vegetation, and only 15 percent of the corridor are forested. Although streamside fencing is present in some locations, it has been constructed so close to the stream that protection of a fully functional riparian corridor is limited.

Subbasin Alteration Matrix

The subbasin alteration matrix (Table 6-11) indicates a high level of alteration in Subbasin 2. Scoring of all of the criteria indicated a high level of alteration except for stream crossings, which were rated low, and flow modification, which was rated moderate. These results suggest that there are numerous impairments to ecological functioning of Subbasin 2, and that instream, riparian and floodplain habitats are significantly degraded.

6.3.3 Benthic Biodiversity

No B-IBI data exist for Subbasin 2.

6.3.4 Summary

Field Assessment

The habitat conditions of Boise Creek in Subbasin 2 were assessed at the 268th Avenue and 276th Avenue road crossings. Ratings were the same at both locations for all of the habitat criteria.

TABLE 6-11.
SUBBASIN ALTERATION MATRIX FOR SUBBASIN 2

Criteria	Level of Alteration		
	High	Moderate	Low
Effective Impervious Area	22% EIA		
Landscape Alteration	5% of the historical area		
Impact from Culverts and Other Stream Crossings			1.6 crossings/mile
Flow Modification (Q _{2post} /Q _{2pre} ratio)		1.27 – 1.29	
Channel Modifications and Floodplain Connectivity	100% of the channel has been altered		
Riparian Alteration	15% forested		

Fish passage and substrate composition in spawning areas were the only criteria rated as good. Spawning habitat is occurring in run habitats dominated by gravel substrate, and salmon were observed spawning in this reach during field reconnaissance in the fall of 2003. However, the substrate embeddedness was rated as fair, indicating that a moderate level of fine sediment deposition has somewhat degraded spawning habitat quality. Bank condition was fair due to pervasive domination of the riparian zone by reed canary grass and Himalayan blackberry. Pool frequency, channel pattern/bedform, and LWD abundance were also rated as poor. Riparian habitat was poor because there is less than a 25-foot-wide vegetated buffer along the stream in most areas. The stream channel/bedform was in poor condition due to straightening and channelization. Large woody debris abundance was extremely low; in fact, practically no LWD was seen in the stream channel.

Habitat Value

In spite of the aforementioned impacts, this reach has high-habitat-value for salmonid spawning and possibly also for rearing. Under the pristine conditions that prevailed in pre-settlement times, it can be assumed that this subbasin had high salmonid production potential as evidenced by historic U.S. Land Survey maps that indicate the presence of large riparian wetlands. However, alterations to this reach have severely decreased habitat conditions and functions, as well as salmonid production, although a surprisingly level of salmonid spawning still occurs in this reach.

Rating

Subbasin 2 is in generally poor condition. Floodplain channel types are extensively used by salmonids for spawning and rearing because of the natural abundance of high quality spawning gravels (R2 Resources 2001) and off-channel habitats. This reach of Boise Creek is currently degraded and in poor condition, mainly due to a lack of riparian vegetation and channelization of the stream. The reach has low habitat complexity, few to no pools, moderate levels of fine sediment that degrades spawning substrate quality, poor riparian habitat, very little overhanging vegetation and canopy cover, and lack of LWD.

State of the Subbasin

This entire reach has been impacted by agricultural and rural-residential development. The riparian habitat has been denuded of trees, the straightened stream channel lacks LWD and therefore this reach lacks habitat diversity. Although the reach still contains extensive spawning habitat, rearing habitat is much more limited due to the lack of pools, hydraulic complexity, overhanging cover, and off-channel habitat. Restoration efforts in this reach need to first focus on reestablishing a healthy riparian corridor, then move toward increasing habitat complexity by alleviating channelization and restoring off-channel habitat where possible. Since the stream channel lacks LWD, placing LWD in the channel is a preferred method for improving habitat complexity. At the same time, consideration must be given to the need to limit flood hazards. One approach would be to construct modestly sized setback levees within which the stream could meander within a restored riparian corridor that could provide for future LWD recruitment into the channel and adjacent floodplain.

6.4 SUBBASIN 3 STREAM HABITAT CLASSIFICATION RESULTS

6.4.1 General Characteristics (Beaver Creek: RM 0.0 – 2.5)

Subbasin 3 consists of the Beaver Creek (WRIA #10.0059) subbasin. Beaver Creek begins as a high-gradient contained channel type and flows down through a moderate-gradient contained reach, and thence into a floodplain channel type before entering the left bank of Boise Creek at RM 3.2 (Figure 6-1). The headwaters of this subbasin were historically forested, but logging has removed much of the riparian vegetation and created numerous stream crossings. Rural residential and agricultural land uses have altered the lower portions of the subbasin, removing a significant amount of the riparian vegetation and channelizing some segments the stream. Table 6-12 summarizes the channel types in Subbasin 3.

TABLE 6-12. LENGTH OF EACH CHANNEL TYPE ALONG BEAVER CREEK IN SUBBASIN 3	
Stream Type	Length (feet)
Alluvial Fan	0
Floodplain	7,740
High Gradient Contained	10,240
Moderate Gradient Contained	7,804
Moderate Gradient Mixed Control	0
Palustrine	0
Total	25,784

6.4.2 Subbasin Alteration

Effective Impervious Area

Subbasin 3 is 1,195 acres in size and has 26 acres of impervious area, yielding a 2 percent EIA, which indicates a low level of watershed impact (Table 6-14), and minimal alteration of the hydrologic regime of the Beaver Creek Subbasin.

Landscape Alteration

Under predeveloped conditions, 1,194 acres of forested land cover was present in Subbasin 3. Currently, 518 acres of forested land cover remain or 43 percent of the historical area, indicating a high level of alteration.

Impact from Culverts and Other Crossings

In Subbasin 3, there are 13 stream crossings, yielding 5.0 crossings/mile of stream, a moderate level of alteration. It is likely that all of these crossings are culverts, six of which underlie logging roads in the upper reaches of the subbasin. The culvert at 288th Avenue SE was a known barrier to fish passage and was rated as high. King County replaced this culvert in 2003.

Flow Modification

In Subbasin 3, flow modification has occurred, indicated by a $Q2_{post}/Q2_{pre}$ ratio of 1.40 for RCHRES segment 300 (Table 6-13). This indicates a moderate modification to the hydrologic regime.

TABLE 6-13. PRE-DEVELOPED AND POST- DEVELOPED 2-YEAR AND RATIO; RCHRES SEGMENT 300 IN SUBBASIN 3	
$Q2_{pre}$	144 cfs
$Q2_{post}$	202 cfs
$Q2_{post}/Q2_{pre}$ ratio	1.40

Channel Modifications and Floodplain Connectivity

Subbasin 3 has undergone a moderate level of channel modification. The lower 30 percent of the stream has been channelized and straightened, and is constrained by 284th Avenue SE. In addition, livestock have trampled the stream banks in the reach between 284th Avenue SE and 288th Avenue SE. These alterations also impair floodplain connectivity.

Riparian Alteration

The riparian habitat of Subbasin 3 is highly altered and in poor condition. Agricultural, residential, and forest practices have created numerous riparian breaks and removed a

significant amount of the riparian corridor. Only 44 percent of the riparian corridor in this subbasin is forested.

Subbasin Alteration Matrix

A high level of watershed alteration has occurred in Subbasin 3 (Table 6-14). In particular, there has been a high level of alteration to the surrounding landscape, the stream channel, and the riparian habitat. In addition, there is a moderate level of impact from stream crossings and modification of the hydrologic regime.

TABLE 6-14. SUBBASIN ALTERATION MATRIX FOR SUBBASIN 3			
Criteria	Level of Alteration		
	High	Moderate	Low
Effective Impervious Area			2% EIA
Landscape Alteration	43% of the historical area		
Impact from Culverts and Other Stream Crossings		5.0 crossings/mile	
Flow Modification ($Q^2_{\text{post}}/Q^2_{\text{pre}}$ ratio)		1.40	
Channel Modifications and Floodplain Connectivity	30% of the stream length altered		
Riparian Alteration	44% forested		

6.4.3 Benthic Biodiversity

No B-IBI data exist for Subbasin 3.

6.4.4 Summary

Field Assessment

Beaver Creek was assessed where it parallels 284th Avenue SE and at the 288th Avenue SE stream crossing. Fish passage along 284th Avenue is good, but all other habitat criteria were rated as poor. Beaver Creek has been extremely degraded and confined in a roadside ditch, the stream banks are eroding, riparian habitat is absent along the entire right bank, there are no pools or LWD, and the substrate is composed of sand and fines.

A fish passage barrier due to a hung culvert under 288th Avenue SE was repaired in 2003 by the King County Roads Services Division. Prior to this project salmonid passage was blocked. The riparian habitat in the vicinity of the road crossing is in fair condition due to encroachment by private residences on the riparian corridor. No spawning habitat was seen at this site, which is dominated by cobble substrate. Embeddedness was only slight since this is a moderate-gradient, high-energy reach where fine substrates are unlikely to settle. While the stream banks were relatively well vegetated and in good condition, pool frequency, channel pattern/bedform, and LWD abundance were rated as poor. In this

segment there is little instream LWD influencing channel morphology, and thereby maintaining habitat complexity.

Habitat Value

Subbasin 3 is a moderately complex subbasin in that the stream geomorphology varies from moderate- and high-gradient channels in the upper watershed to a floodplain channel type near the confluence with Boise Creek. In pristine condition, this subbasin likely provided a broad diversity of spawning and rearing habitats. Now however, potential spawning habitat in the upper watershed is hindered by culverts, and the stream channel and riparian corridor in the lower watershed have been severely degraded due to floodplain filling and channelization. These impacts have significantly decreased the current salmonid production potential of Subbasin 3.

Rating

The stream habitat in Subbasin 3 is in poor condition due to agricultural practices, channelization, and fish passage barriers posed by road culverts. The highly degraded condition of the habitat in this stream provides poor to moderate salmonid habitat. The watershed is moderately altered, fish passage is impaired, much of the riparian habitat is in poor condition, and the stream has been channelized in a ditch along 284th Avenue SE and encroached on by pasturelands downstream of 284th Avenue SE.

State of the Subbasin

The Beaver Creek subbasin has been subjected to a high level of alteration from agricultural land use practices, rural residential development, and forest practices. Since degradation of the stream channel, riparian habitat, and fish passage barriers are the primary habitat-limiting factors in this subbasin, these problems should be the focus of restoration efforts in order to increase fish production within the Beaver Creek subbasin.

6.5 SUBBASIN 4 STREAM HABITAT CLASSIFICATION RESULTS

6.5.1 General Characteristics (Boise Creek: RM 3.2 to 4.4)

The segment of Boise Creek that flows through Subbasin 4 is a floodplain channel type that lies mostly within the Enumclaw Golf Course. Channel types are presented in Table 6-15. This reach extends from the mouth of Beaver Creek to a waterfall just upstream of the golf course. An unnamed tributary enters the right bank of Boise Creek through a culvert near the upstream end of the golf course. Within the golf course, Boise Creek is dominated by riffle and run habitats. Downstream and upstream of the golf course the stream flows through forested reaches with more complex habitat and abundant pools, representative of more natural conditions (O'Rollins 1993).

The golf course is in a depositional zone where the stream transitions from the moderate gradient (3.2 percent) channel upstream to the low gradient (0.5 percent) reach within and downstream of the golf course. A habitat assessment conducted by King County staff in 1992 (O'Rollins 1993) reported that the reach of Boise Creek within the golf course is extremely degraded because it is devoid of riparian vegetation and LWD and has little pool

habitat. In addition, the stream has been straightened and channelized, berms have been constructed to prevent overbank flow, and the channel has been dredged to alleviate flooding. Despite these poor habitat conditions, the substrate is in good condition because of the continual deposition of gravel substrates (O'Rollins 1993) that are perfectly sized for salmonid spawning. Thus, 80 percent of the salmon and steelhead that spawn in the Boise Creek Basin spawn in Subbasin 4. Several hundred chinook salmon were seen spawning in the golf course in late September 2003 (Army Stonkus, Tom Beavers, and Ruth Schaefer, September 25, 2003).

TABLE 6-15. LENGTH OF EACH CHANNEL TYPE ALONG BOISE CREEK IN SUBBASIN 4	
Stream Type	Length (feet)
Alluvial Fan	0
Floodplain	6,184
High Gradient Contained	0
Mod. Gradient Contained	0
Moderate Gradient Mixed Control	12
Palustrine	0
Total	6,196

In response to the severe habitat degradation of Boise Creek by the Enumclaw Golf Course, King County has proposed relocating 1,500 feet of the existing stream channel into a relatively well-vegetated remnant channel to the east of the current channel alignment (Tom Beavers, Boise Creek Stream Steward, King County, personal communication). The habitat-specific goals of this project are to restore instream habitat, floodplain processes and functions, riparian habitat, and sediment routing through the reach, and to improve water quality. This channel relocation and rehabilitation should alleviate many of the habitat impairments and increase the potential spawning and rearing habitat in this reach of Subbasin 4. Depending on how it is designed, it could also help reduce flooding during severe storms and improve aesthetic conditions within the golf course.

6.5.2 Subbasin Alteration

Effective Impervious Area

Subbasin 4 is 703 acres in size and has 82 acres of impervious area, yielding a 10 percent EIA, a high level of alteration. This level of alteration may have a significant influence on the hydrologic regime of the stream in this subbasin.

Landscape Alteration

Under predeveloped conditions, 784 acres of forested land cover was present in Subbasin 4. Under existing conditions, 484 acres of forested land cover remain or 62 percent of the historical area. This is a moderate level of landscape alteration.

Impact from Culverts and Other Crossings

There are four bridges crossing Boise Creek in Subbasin 4, three of which are golf cart paths in the Enumclaw Golf Course, yielding 3.4 crossings/mile, a moderate level of alteration. The WRIA 10 report (Kerwin 1999) indicated that the golf course bridges constrict the channel, and that the 284th Street Bridge causes considerable constriction. Culverts and cart path crossings have also degraded the small tributary that enters Boise Creek near the upstream end of this subbasin. A stretch of this tributary flows through a culvert under the Corliss gravel mine, north of SR-410. Downstream from the gravel mine, the stream passes through an undersized and dysfunctional culvert under SR-410, and within the golf course it flows under golf cart path bridges and through a long culvert before emptying into Boise Creek.

Flow Modification

In Subbasin 4, the $Q2_{post}/Q2_{pre}$ ratio of 1.26 corresponds with the lower threshold of the "moderate" zone of the flow modification scale shown in Table 6-16.

TABLE 6-16. PRE-DEVELOPED AND POST- DEVELOPED 2-YEAR AND RATIO; RCHRES SEGMENT 400 IN SUBBASIN 4	
$Q2_{pre}$	390 cfs
$Q2_{post}$	490 cfs
$Q2_{post}/Q2_{pre}$ ratio	1.26

Channel Modifications and Floodplain Connectivity

Approximately 70 percent of the total length of channel in Subbasin 4 has been altered by land use practices. The Enumclaw Golf Course reach has been significantly altered by channelization, construction of levees, bank stabilization with riprap, dredging of the streambed, and ongoing removal of nearly all riparian vegetation. The downstream half of the reach flows through an agricultural/residential land where the stream has been channelized and much of the riparian vegetation removed. Floodplain connectivity is impaired throughout much of this reach by levees and floodplain filling.

Riparian Alterations

The riparian habitat of Subbasin 4 is highly altered, with only 36 percent of the riparian corridor forested. Riparian vegetation is removed periodically from much of the Enumclaw Golf Course reach. Residential and agricultural activities have also removed or reduced the riparian corridor in the lower half of the subbasin.

Subbasin Alteration Matrix

The subbasin alteration matrix for Subbasin 4 (Table 6-17) indicates a high level of alteration. All of the criteria were rated at a moderate level of alteration or greater. The

stream channel and riparian habitat have been highly altered and are the primary habitat impairments in the subbasin. Improving riparian habitat and alleviating the effects of the channel alterations and floodplain filling should be the primary habitat improvement objectives for the subbasin.

6.5.3 Benthic Biodiversity

B-IBI data were collected in 1999 and 2000 by King County at the Water Quality Sampling Location E2154, at the bridge on 284 Avenue SE that crosses Boise Creek at the downstream end of Subbasin 4. Table 6-18 shows scores from these data. The low values for all of the parameters suggest that the downstream end of this subbasin reach is in poor condition. These results correspond with the other criteria in this investigation that suggest that Subbasin 4 has been highly altered and the habitat is degraded.


TABLE 6-17. SUBBASIN ALTERATION MATRIX FOR SUBBASIN 4			
Criteria	Level of Alteration		
	High	Moderate	Low
Effective Impervious Area		10% EIA	
Landscape Alteration		62% of the historical area	
Impact from Culverts and Other Stream Crossings		3.4 crossings/mile	
Flow Modification ($Q^2_{\text{post}}/Q^2_{\text{pre}}$ ratio)		1.26	
Channel Modifications and Floodplain Connectivity	70% of the stream length modified		
Riparian Alteration	36% forested		

TABLE 6-18. B-IBI METRIC SCORES FOR BOISE CREEK AT 284TH AVENUE SE		
	1999 ^a	2000
Total No. Taxa	2	3
E Richness	3	1
P Richness	3	3
T Richness	3	1
Site Score	15	22
Average E Richness	2.67	3.67
Average P Richness	1.33	3.33
Average T Richness	3.67	3
a. Scores from 1999 are based on the 5-metric method; scores from 2000 are based on the 10 metric method		

6.5.4 Summary

Field Assessment

Field assessments of Boise Creek in Subbasin 4 were conducted immediately upstream of 284th Avenue SE, within the Enumclaw Golf Course and on the right bank tributary that enters Boise Creek at approximately RM 4.25. Additional field assessments were conducted by King County staff in the fall of 2003 during the chinook salmon spawning season.

Directly upstream of 284th Avenue SE, Boise Creek flows through private property. In this segment, fish passage and spawning substrate were good and embeddedness was low, but because of riparian vegetation removal, riparian habitat was judged to be in poor condition, contributing to bank instability on the left bank. The right bank of the stream has also been degraded by placement of riprap armor. The channel pattern/bedform was rated as fair condition since it has retained a degree of natural sinuosity, but no side channels or secondary habitats were present. In addition, no pools or LWD were observed in this stream segment.

Within the Enumclaw Golf Course, the stream habitat has been significantly degraded by channelization and periodic dredging. Although spawning substrate was in relatively good condition and embeddedness was low, all other criteria were indicative of moderate to severe habitat impairment. Fish passage was unimpaired in the Boise Creek mainstem, but the culvert within the golf course that conveys the unnamed right bank tributary into Boise Creek is not fish passable at during low flows. Riparian vegetation is absent through much of the golf course, contributing to bank erosion and instability. The stream channel pattern/bedform was rated as poor since portions of this reach have been channelized and

straightened. Because pools and LWD were infrequent, this segment of the stream was classified as being in poor condition.

The unnamed tributary that enters Boise Creek at approximately RM 4.25, is extremely degraded and in poor condition. Fish passage was poor because the stream flows through multiple culverts that are not functioning properly. All other habitat criteria were rated as poor in this stream segment because riparian vegetation is removed on an ongoing basis and the golf course fairways are adjacent to the stream. No LWD or pool habitats are present, and the channel is a straight and shallow. Nonetheless, juvenile salmonids use this channel as over-wintering habitat (Tom Beavers, King County DNR, November 2003).

Habitat Value

In spite of these pervasive impacts, Subbasin 4 is a high-value reach of Boise Creek since the majority of salmon and steelhead spawning that occurs in the entire Boise Creek basin takes place in this reach. It appears that the continual replenishment of spawning gravels transported into this reach from upstream sources maintains the biological productivity of this reach.

Rating

In Subbasin 4, Boise Creek is a floodplain channel type that is in poor condition due to channelization, floodplain filling, removal of riparian vegetation, streambank instability, and lack of LWD and pools. Although habitat in this reach is structurally homogenous and in generally poor condition, this reach supports a high abundance of spawning salmonids, including chinook salmon, relative to the other Boise Creek subbasins. Floodplain channel types typically have diverse habitats and channel morphology and thus provide high quality spawning and rearing habitat (R2 Resources 2001).

State of the Subbasin

This habitat analysis indicates that Subbasin 4 has been significantly degraded and the habitat is in poor condition. However, since this reach is a transition area between the moderate-gradient channel types upstream and the floodplain channel type downstream, abundant spawning gravel deposit in this reach. This process creates high quality spawning habitat throughout the subbasin despite the habitat impairments. King County has recommended seven stream restoration projects in this reach, including the addition of LWD, riparian revegetation, and relocation of the most impaired 1,500-foot section of the channel within the golf course to a relatively well vegetated remnant stream channel to the east. These actions will alleviate many of the habitat impairments in this subbasin.

6.6 SUBBASIN 5 STREAM HABITAT CLASSIFICATION RESULTS

6.6.1 General Characteristics (Boise Creek: RM 4.4 – 5.4)

Subbasin 5 is a moderate-gradient, moderately contained stream reach located between State Route (SR) 410 and the Enumclaw Golf Course. SR 410 parallels the stream channel though approximately 80 percent of this reach, confining a portion of the channel, impairing floodplain connectivity, and degrading the riparian habitat. A 15-foot high,

impassable waterfall just upstream of the golf course currently marks the upstream extent of anadromous fish passage in the basin. However, it is possible that Boise Creek was relocated south of its original route that may have flowed through a shallow ravine, which is now occupied by a segment of SR 410. If this is indeed the case, it is possible that most species of anadromous fish ascended Boise Creek all the way to a steep natural cascade at RM 6.3. Table 6-19 summarizes the channel types in Subbasin 5.

TABLE 6-19. LENGTH OF EACH CHANNEL TYPE ALONG BOISE CREEK IN SUBBASIN 5	
Stream Type	Length (feet)
Alluvial Fan	0
Floodplain	0
High Gradient Contained	0
Moderate Gradient Contained	0
Moderate Gradient Mixed Control	6,251
Palustrine	0
Total	6,251

6.6.2 Subbasin Alteration

Effective Impervious Area

Subbasin 5 is 534 acres in size and has 36 acres of impervious area, yielding a 7 percent EIA, indicative of a moderate level of alteration. However, even this level of alteration is enough to impact the hydrologic regime of the subbasin.

Landscape Alteration

Under predeveloped conditions, 534 acres of forested land cover was present in Subbasin 5. Under existing conditions, 460 acres of forested land cover remain or 86 percent of the historical area. This represents a low level of landscape alteration.

Impact from Culverts and other Crossings

There are no stream crossings on Boise Creek in Subbasin 5, but a small tributary enters Boise Creek through a culvert under SR-410. Approximately 200 feet of the tributary is also contained in a culvert that is impassable at some flows.

Flow Modification

The Q2post/Q2pre ratio is 1.20 for RCHRES segment 500 (Table 6-20), a low level of flow modification.

TABLE 6-20.
PRE-DEVELOPED AND POST-
DEVELOPED 2-YEAR AND RATIO;
RCHRES SEGMENT 500 IN SUBBASIN 5

Q ₂ _{pre}	353 cfs
Q ₂ _{post}	423 cfs
Q ₂ _{post} /Q ₂ _{pre} ratio	1.20

Channel Alterations and Floodplain Connectivity

A high level of alteration has occurred to the stream channel and floodplain connectivity in Subbasin 5. Highway 410 parallels and is directly adjacent to approximately 80 percent of the stream reach. This has resulted in constriction of the channel and floodplain to a third of its normal width (Kerwin 1999).

Riparian Alterations

In Subbasin 5, the riparian habitat is moderately to highly altered. While 52 percent of the riparian corridor is forested, the riparian vegetation along approximately 40 percent of the total stream length has been reduced along Highway 410.

Subbasin Alteration Matrix

The subbasin alteration matrix for Subbasin 5 (Table 6-21) indicates a high level of alteration. In particular, the stream channel and riparian habitat have been highly altered and are the primary habitat impairments in the subbasin. These alterations are due to the close proximity of SR-410 through much of this reach.

6.6.3 Benthic Biodiversity


No B-IBI data exist for Subbasin 5.

6.6.4 Summary

Field Assessment

A field assessment was performed on the reach of Boise Creek downstream of SR- 410. No artificial fish passage barriers were observed, but it was noted that SR-410 significantly degrades the riparian habitat within the upstream portion of this reach due to encroachment into the riparian corridor. The spawning substrate is dominated by moderately coarse, moderately embedded gravels that were judged to be in fair condition.

TABLE 6-21.
SUBBASIN ALTERATION MATRIX FOR SUBBASIN 5

Criteria	Level of Alteration		
	High	Moderate	Low
Effective Impervious Area		7% EIA	
Landscape Alteration			86% of the historical area
Impact from Culverts and Other Stream Crossings			0 crossings/mile
Flow Modification (Q ² _{post} /Q ² _{pre} ratio)			1.20
Channel Modifications and Floodplain Connectivity	60% of the stream length modified		
Riparian Alteration	41% forested		

The stream banks were also judged to be in fair condition, although encroachment by SR-410 has caused bank instability and erosion on the right bank. For this same reason, the channel pattern/bedform was rated as fair. Large woody debris abundance varies from fair within the upstream half of the reach, to very high in the vicinity of a large logjam. The logjam was created following the erosion of a mid-1990's King County bank stabilization project. The logs were transported from this project and came to rest in a flatter gradient area within the forest south of SR-410. Much sediment has accumulated in the interstices of the jam, and additional natural LWD has been recruited at this location, forming excellent fish habitat.

Habitat Value

Subbasin 5 is inaccessible to anadromous salmonids but is of high value for resident fish. The falls at the downstream end of Subbasin 5 prevent upstream fish passage into the subbasin. However, numerous resident salmonids use this reach for spawning and rearing (Ruth Schaefer and Arny Stonkus KC WLRD Senior Ecologists, October 2003) and cutthroat ranging in size from small fry to 8 inches in length were seen during field reconnaissance in the fall of 2003. It is important to maintain the integrity of this reach in order to support the currently viable population of cutthroat trout and prevent further degradation of downstream habitats.

Rating

The stream habitat in Subbasin 5 was judged to be in generally poor condition due to encroachment by SR-410 on the stream channel buffer through much of the reach, increasing erosion, and the ability of the reach to transport sediment. However, the downstream end of the reach is in much better condition due to the presence of a large logjam surrounded by dense riparian vegetation. Downstream of the jam, Boise Creek

flows through a steeper, bedrock-lined channel that contains very little gravel and sparse LWD.

State of the Subbasin

In Subbasin 5, Boise Creek has been heavily modified by Highway 410. The construction of the road prism has not only constrained the stream channel, it appears that the channel may have been relocated south of its original course in the vicinity of the highway, resulting in altered hydraulics, a substantially reduced floodplain, and increased erosion and transport of fine sediments to downstream reaches. In addition, the road has encroached on the riparian habitat along the right stream bank. Addition of LWD will also help reduce the effects of these historic channel alterations on downstream reaches, in particular the transport and deposition of sediments within the Enumclaw Golf Course. In addition, there are opportunities to improve habitat in this reach by removing invasive, non-native plants and underplanting the riparian corridor with conifers. It may also be feasible to reroute the lower portion of this reach into a newly created, flatter-gradient channel to the north of its present course, thereby allowing anadromous fish to access the upper watershed.

6.7 SUBBASIN 6 STREAM HABITAT OVERVIEW

A short portion of Boise Creek flows through Subbasin 6. The subbasin is mostly forested and contains a lumber mill site owned by Weyerhaeuser located at the southwestern and downstream end of the subbasin. Boise Creek flows into Subbasin 6 before entering a culvert system that carries the stream through the mill site. Therefore, the mill site segment of Boise Creek provides little if any fish habitat. The land surrounding the mill site is an actively managed commercial forest and consists of a mix of clearcuts, regenerating clearcuts, and pockets of mature forest made up of regenerated clearcuts. At present, the large culvert system under the mill site prevents resident fish passage between Subbasins 5 and 7.

6.8 SUBBASIN 7 STREAM HABITAT OVERVIEW

Subbasin 7 contains the headwaters of Boise Creek in the foothills of the Cascade Mountains. Most of this reach is a moderate-gradient contained channel type, fed by numerous high gradient tributaries. The surrounding commercial forest is made up primarily of regenerating clearcuts and forest service roads. The forest service culverts need to be properly maintained to prevent catastrophic road failures that could cause sediment deposition in downstream areas.

6.9 BASIN SUMMARY

This habitat analysis indicates that the Boise Creek Basin downstream of SR-410 has been altered and degraded, but still contains highly productive patches of fish habitat. The most productive areas are in Subbasin 4, which flows through the Enumclaw Golf Course, where anadromous fish spawn in high densities; and in Subbasin 5 in the vicinity of a large logjam in the ravine adjacent to SR-410 that provides outstanding habitat for resident trout. The mainstem of the creek has 4.5 river miles available to anadromous salmonids; all but the lower 0.5 RM potentially is valuable spawning and rearing habitat. However, salmonid spawning is limited primarily to Subbasins 4 and 5. (Ruth Schaefer and Tom Beavers,

October 2003. The continual deposition of gravels in Subbasin 4 has allowed clean gravel substrates to persist despite a high level of alteration to the stream channel and the riparian habitat. Improvement of the remaining 3 miles of habitat in addition to the golf course reach should substantially increase the salmonid production in the system.

Boise Creek has also been identified on the Washington State 303(d) list of impaired water bodies due exceedance of water quality standards for temperature. These high water temperatures are probably a result of the poor riparian habitat in the basin and are one of the many problems that can be associated with such conditions. Revegetation of denuded riparian areas will help moderate stream temperatures and improve water quality throughout the basin.

The factors limiting salmonid habitat are present throughout the Boise Creek Basin, except for the steep headwater areas in Basin 6. Therefore, habitat improvement needs for the basin are large-scale and apply somewhat uniformly throughout the basin. Improvement of riparian conditions along Boise Creek and the stream channel poses the greatest potential for beneficial long-term improvement of instream habitat. By providing healthy riparian conditions, many of the limiting factors identified in this report would be alleviated; stream temperatures likely could fall to within water quality standards, and stabilized stream banks would reduce erosion and sedimentation and provide long-term recruitment of LWD to the channel. Increasing the abundance of LWD would increase habitat complexity, creating pools and off-channel habitats, and thereby increasing hydraulic refuge and cover (Hicks et al. 1991). All of these habitat components work together to form a healthy and productive salmonid stream.

6.10 RECOMMENDATIONS

The following recommendations are based on the findings presented in this chapter:

- **Riparian Habitat Restoration**—Riparian habitat degradation from agricultural and grazing land use practices, and residential and commercial development is a widespread habitat impairment in the Boise Creek Basin and should be addressed throughout the basin. It would be beneficial to enforce the required riparian buffer laws by following the Rules and Regulations of the King County Department of Development and Environmental Services, Chapter 21A-38, Stream Corridors P-suffix (BCP-P2).

The riparian habitat of many stream reaches in the Boise Creek watershed has been overtaken by reed canary grass and Himalayan blackberry. Areas dominated by these invasive species should be revegetated with native shrubs and trees.

Riparian habitat restoration in the Boise Creek Basin is a programmatic restoration action that will require extensive cooperation with private landowners. Land and riparian easements could be acquired in various locations to implement this recommendation.

- **LWD Placement**— Nearly all of the study area is devoid of LWD and would benefit from placement of LWD, preferably large coniferous logs with rootwads. The floodplain channel types should be the highest priority for

LWD placement and would undergo the greatest beneficial change from the restoration of spawning and rearing habitat. Large woody debris could also be used to replace riprap or other bank stabilization measures in the basin. Bioengineered bank stabilization structures containing LWD could be installed at locations that are constrained by adjacent land uses in order to stabilize the bank and enhance habitat conditions. LWD placement and bioengineering projects may have to be combined with levee setbacks to maintain hydraulic conveyance in floodprone areas. This is a programmatic restoration action that will require extensive cooperation with public and private landowners.

- **Beaver Creek Stream Channel Improvement**—Beaver Creek is channeled for approximately a half mile along 284th Avenue SE. Restoration of this reach should include reconstruction of a sinuous channel, placement of LWD, and revegetation of the stream banks. The project could either expand and enhance the existing channel or, ideally, relocate the channel further away from the road. Acquisition of private property would be necessary to implement this recommendation.
- **Beaver Creek Culvert**—The culvert on Beaver Creek at 288th Avenue SE has recently been replaced to remove a fish passage barrier. Fish habitat utilization upstream should be monitored in the late fall, winter, and spring to ensure that fish can access and reproduce in habitat upstream from the new culvert.
- **Subbasin 4 Private Property Stream Restoration**—The left bank of Boise Creek at a private residence just upstream of 284th Avenue has been protected with riprap and nearly all of the native riparian vegetation has been removed from this reach. A restoration project at this location would include revegetating the stream banks and replacing the riprap bank armor with bioengineered bank stabilization materials that include LWD in order to provide bank protection and better fish habitat.
- **Boise Creek Enumclaw Golf Course Habitat Restoration and Channel Relocation**—Boise Creek and the right bank tributary at approximately RM 4.2 have been severely degraded by the Enumclaw Golf Course. Habitat restoration in this reach should include restoration of the riparian habitat and addition of LWD into the stream channel and terracing of the banks to increase the channel cross section, thereby decreasing flow velocities, increasing conveyance and habitat diversity. In addition, King County has proposed relocating 1,500 feet of the existing stream channel to a remnant channel to the east. This channel relocation and rehabilitation should alleviate many of the habitat impairments, increase the quality and quantity of spawning and rearing habitat in this reach of Subbasin 4, and reduce flooding and sediment deposition in the golf course.
- **Golf Course Tributary Culvert**—The culvert that conveys the right bank tributary into Boise Creek near the upstream end of this reach is partially plugged and should be replaced with a larger culvert (SR 410). The 200-foot culvert at the mouth of the stream should also be removed and replaced with an open channel. In addition, the feasibility of connecting this

tributary with a patch of wetland habitat upstream should be investigated. This could be enhanced with LWD and plantings of native riparian species to provide overwintering habitat. There is limited fish habitat upstream of the SR 410 culvert.

- **Subbasin 5 Riparian Conifer Plantings**—The riparian habitat of the lower reach of Subbasin 5 is dominated by deciduous trees. Planting coniferous trees in this reach would increase the long-term recruitment of coniferous LWD to the stream reach.
- **Subbasin 5 Bank Stabilization, LWD Placement, and Riparian Revegetation**— The stream reach adjacent to SR-410 is significantly degraded. Habitat improvements in this reach should include revegetation of the riparian corridor, bank stabilization using bioengineering methods, conifer underplantings, and placement of larger clusters of LWD within the bank channel. Bank stabilization structures should use LWD to the maximum extent practicable to enhance fish habitat. Consideration should be given to relocating Boise Creek into a new alignment north of its current location near the downstream end of this reach in order to allow anadromous fish to access the upper watershed.
- **Weyerhaeuser Property Land Acquisition and Stream Restoration**—Tom Beavers (Boise Creek Stream Steward, King County, personal communication) indicated that the Weyerhaeuser mill site upstream of Highway 410 will be sold within the next five years. As of the time of publication of this report, the mill had ceased operation and has been put up for sale. A study should be completed to investigate how stream and wetland habitat in the vicinity of the mill and upstream could be improved and interconnected. Currently the base flows for Boise Creek flow through the old mill site and the reach is not fish passable. Acquisition of this property would be the first step in restoring the stream channel in this reach. The study should also address the potential re-creation of a portion of the old mill pond, and ways to protect and restore fish habitat upstream from the mill. Since the lands within Subbasins 6 and 7 are privately owned, landowner cooperation would be needed in order to implement these recommendations.

A habitat restoration plan for the Boise Creek Basin should be developed to prioritize all of the above-mentioned habitat improvement actions and specify the order in which they should be implemented in order to maximize the benefit of these restoration efforts.